

Five years experience with the FICFB-gasification process

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Introduction

The FICFB (**F**ast **I**nternally **C**irculating **F**luidised **B**ed) gasification process [1] is an innovative process to produce a high grade synthesis gas from solid fuels. The basic idea of the FICFB concept is to divide the fluidised bed into two zones, a gasification zone and a combustion zone. Between these two zones a circulation loop of bed material is created but the gases should remain separated. The circulating bed material acts as heat carrier from the combustion to the gasification zone. The compact construction and the use of steam as a gasification agent gives the FICFB-process, developed by TU Vienna in co-operation with AE Energietechnik, a small heat loss and a nearly nitrogen free product gas with a high calorific value of 13 MJ/Nm³ dry gas.

Based on a cold flow model and a 10 kW_{th} test rig a 100 kW_{th} pilot plant (1st pilot plant) was built which has been used for experiments from May 1995 to November 1999. In November 1999 a new 100kW_{th} pilot plant (2nd pilot plant) with the same basic design, but an improved operation performance was installed at the institute and is now used for further experiments. In the frame of the EC-Project "Hydrogen-rich Gas from Biomass Steam Gasification" a 500 kW_{th} gasifier was designed, erected and the experiments with this pilot plant started in September 2000. In July 2000 the construction of the 8 MW_{th} demonstration plant has started and it will be put into operation in September 2001.

Description of the 100kW_{th} pilot plant

Gasifier: The first experiments in the 1st pilot plant were carried out with quartz sand as bed material and wood chips as fuel to find the optimal operation conditions. Then different bed materials were investigated. By using a natural catalyst, which was found during these tests, and gasification temperatures above 750°C the tar content was reduced to about 2 g/Nm³. In 1997 and 1998 different fuels (rape seed grist, brown coal, wet wood chips, clover pellets, sewage sludge pellets, animal residues and barley) were tested. In 1600 hours of operation up to date in the 2nd pilot plant first the influence of temperature and steam fuel ratio on gas composition, tar content and cold gas efficiency with natural catalyst as bed material was investigated. The effect of using a Ni-catalyst as bed material was also tested. The gasifier was also used to explore different gas treatment systems.

Gas Treatment: In December 1996 a heat exchanger was installed to cool down the product gas below 200°C. In 1998 a fixed bed sand filter and in June 1999 a bag filter was installed to separate the product gas from particulates. In April 2000 a packed scrubber was tested to remove the tars from the product gas. In 2001 the separation efficiency of a cyclone was investigated.

Results of the 100kW_{th} pilot plant

The main results of the 2nd pilot plant with wood pellets as fuel and natural catalyst as bed material are shown in table 1.

Table 1. main results of the 2nd pilot plant

hydrogen	30-45 vol%		raw gas	clean gas
carbon monoxide	20-30 vol%	tar	0,5-1,5 g/Nm ³	<20 mg/Nm ³
carbon dioxide	15-25 vol%	particles	10-20 g/Nm ³	<10 mg/Nm ³
methane	8-12 vol%	ammonia	500-1000 ppm	<200 ppm
nitrogen	1-5 vol%	hydrogen sulfide	20-50 ppm	

Description of the 500kW_{th} gasification plant

The aim of the EC-project JOR3-CT97-0196 was the development of a fluidised bed gasification process for the production of a hydrogen rich gas from biomass [2]. To achieve this aim a 500kW_{th} plant was built and tested, a catalyst for fluidised beds was developed and fundamental research on the fluid dynamics were done. The construction of the pilot plant was finished in July 2000 and then the first experiments started. During these experiments problems during heating up of the pilot plant occurred. First gasification experiment were carried out in January 2001.

Results of the 500kW_{th} gasification plant

In general the results of this project are:

- A pilot plant with a thermal power of 500kW was built and first experiments were done. These tests showed, that the necessary circulation rate can be reached easily and the nitrogen content in the product gas is below 5%.
- During the work on the cold flow model a new scaling parameter was introduced.
- A new catalyst for fluidised beds was developed and tested. This catalyst showed high activity in reducing tars and increasing hydrogen content.

Description of the 8MW_{th} demonstration plant

In the frame of industrial centers and networks of competence „K_{IND}/K_{NET}“ at the Austrian ministry of economic and labour “RENET Austria” was founded by the partners AE Energietechnik, EVN, Guessinger Fernwaerme and Institute of Chemical Engineering, Fuel and Environmental Technology. Within this network a 8 MW_{th} demonstration plant is under construction. The start up will be in September 2001. In this plant the FICFB-technology of a steam blown dual fluidised bed gasifier will be realised. The gas will be cooled and cleaned to a level, that it can be used in a gas engine. Out of a fuel input of 8 MW there will be 4,5 MW_{th} for the district heating system and an electric output of 2 MW_{el} – first in a demonstration period of two years, later in commercial operation– be produced.

Future aspects

In the next two years the demonstration period of the 8 MW_{th} plant will proceed. Additional research for alternative gas treatment systems will be continued at TU Vienna. Also the application of the product gas as synthesis gas will be studied. Within the EC-Project “Clean Energy from Biomass” NNE5-2000-00212 the product gas of the 500 kW_{th} gasifier will be used downstream a high temperature gas cleaning in a 125 kW_{el} Molten Carbonate Fuel Cell.

Conclusion

The FICFB-gasification system has been developed in the recent years to a status, so that a demonstration plant was built. With this plant on the one hand the necessary scale up from the pilot plant (100 kW_{th}) at TU Vienna to a commercial biomass CHP-plant is realised on the other hand RENET Austria does the necessary R&D, that the industrial partner AE Energietechnik can introduce a marketable and economic biomass CHP on the market. Aim of this development is a CHP-plant with a high electric efficiency and a large range of capacity.

References

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- [2] Hofbauer H, Rauch R, publishable final report EC-Project JOR3-CT97-0196. March 2001